

**Keynote Address:
Fuel Switching in Electricity
Generation: Issues and Challenges –
the Mexican Experience**

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ACADEMIC DEGREES:

Graduated as Metallurgical Engineer from the Chemical Engineering and Extractive Industries School of the National Polytechnic Institute, Mexico (1971).

He obtained a Master Degree on Industrial Economy from the National Polytechnic Institute, Mexico, and attended several specialization courses on Iron and Steel Manufacturing Processes imparted by Kobe Steel, L.T.D. in Japan, as well as an specialization in Planning in Paris, France.

PROFESSIONAL EXPERIENCE:

Among the main positions he has served as a professional are the following:

Investment Manager at Siderurgica Mexicana (Steelworks industry).

Promotion and Development Director at the Mining Industry Development Commission and at the Trust for the Mining Industry Development. He was in charge of promoting, analyzing, evaluating and following up all credits granted by this organization, and also for giving the necessary technical assistance and support to the developing of metal mining and transformation sectors.

In 1989, he received the Annual Award “Ing. Hilario Ariza Davila”, granted by the Council of Graduates of the Chemical Engineering and Extractive Industries School of the National Polytechnic Institute, Mexico, as a recognition for his professional work in the Chemical Engineering field in Mexico.

From 1993 to 1995, he was Coordinator of Regional Promotion and Financing at the National Commission for Energy Conservation (CONAE, for its initials in Spanish), being responsible of implementing the Commission’s criteria and policies in several geographic areas of Mexico.

From 1996 to 1999 he was General Director of Zócalo Asociados, S.A. de C.V.

From 1999 up to date, he has been Energy Coordinator of the Electricity Federal Commission and has been in charge of the Special Program of Carbon Supply for Power Centrals in Mexico.

OTHER PROFESSIONAL ACTIVITIES:

Vice-president of the Mexican Section of the Latin-American Mining Industry Organization.

President of the College of Metallurgical Mining and Geology Engineers of Mexico

Fuel Change in Electricity Generation. The Mexican Experience.

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Background

- Currently, the Mexican Electric System has an installed capacity of 37,000 megawatts (MW). Comisión Federal de Electricidad (CFE) ranks seventh worldwide in installed capacity, with 36,000 MW generated through 154 generating plants, 13 distribution divisions, serving 19 million users, and operating with 74,800 workers.
- According to CFE's goal of continuing to be an efficient and modern company, considering that fuel represents the main cost of electric generation it is necessary for CFE to optimize all of the advantages that allow it to guarantee supply and defend the budget against price volatility in fuel markets.

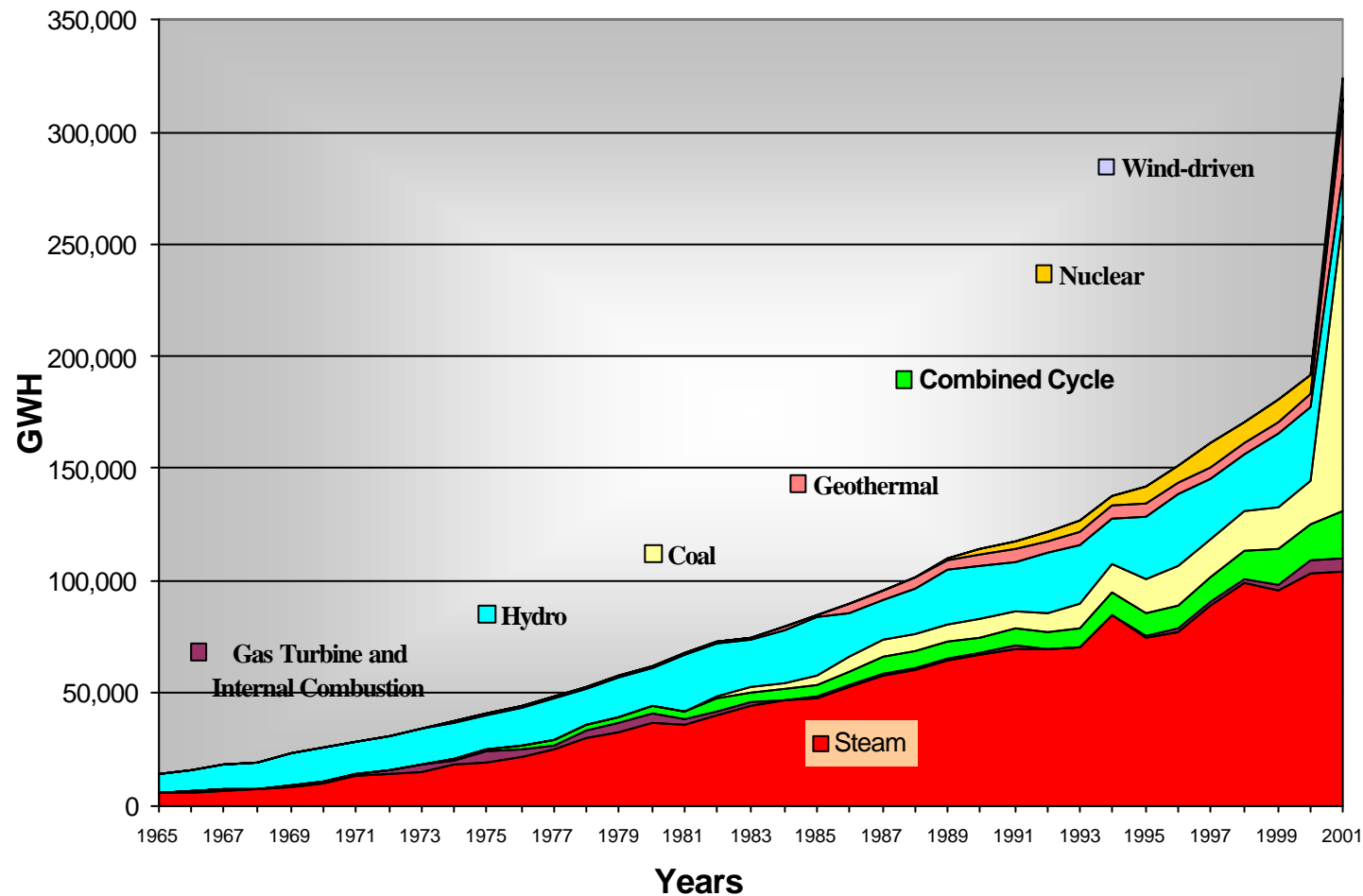
Background

- During the last years, the costs for fuel were the following: \$ 3.2 billion dollars in 1999; \$ 4.9 billion dollars in 2000 and \$5.3 billion dollars in 2001.

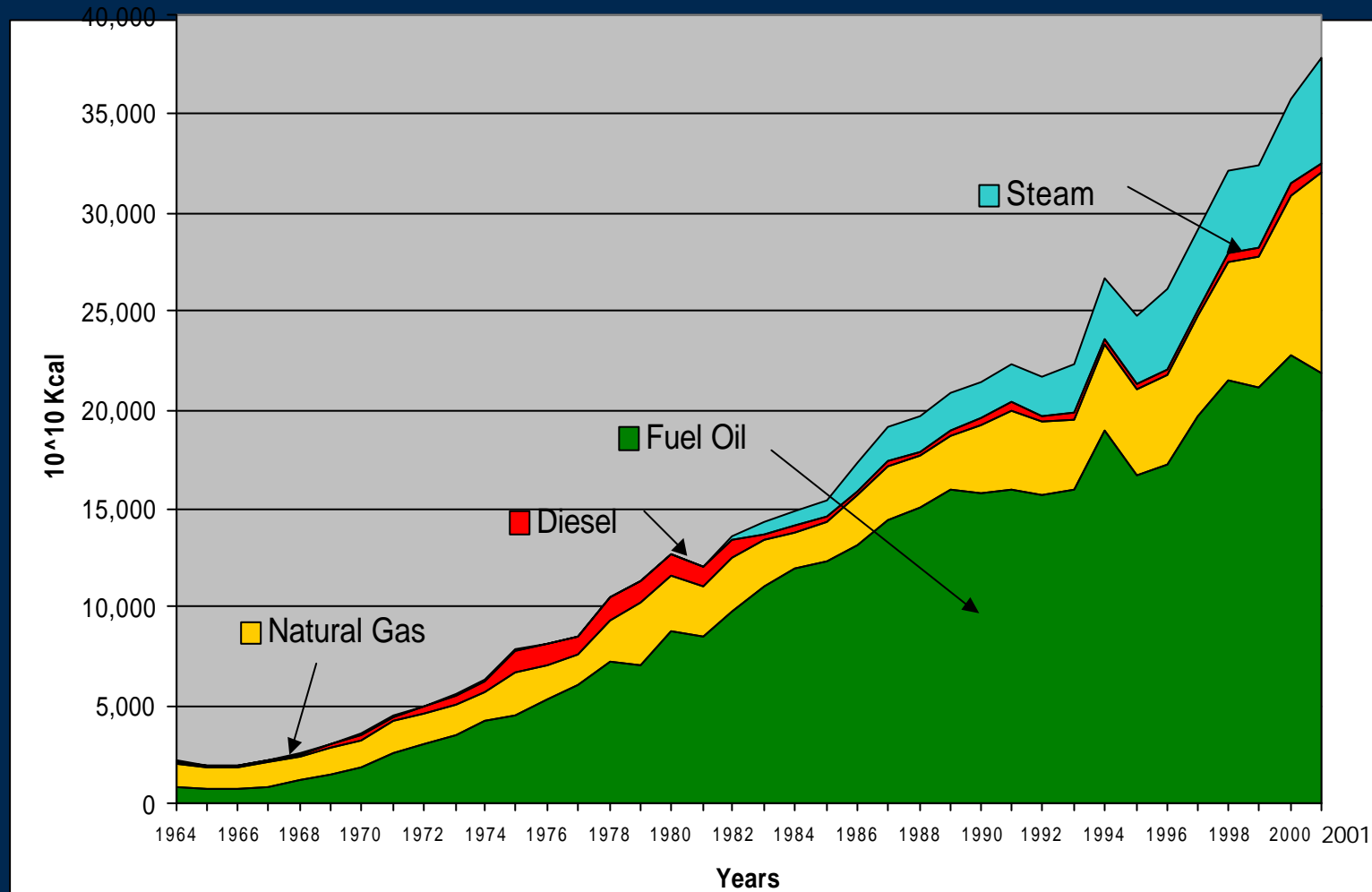
FUEL FOR ELECTRIC POWER GENERATION DURING YEAR 2001

- In 2001 Mexico's National Electric System generated 192,516 GWH.

Evolution of Generation Sources 1965-2001

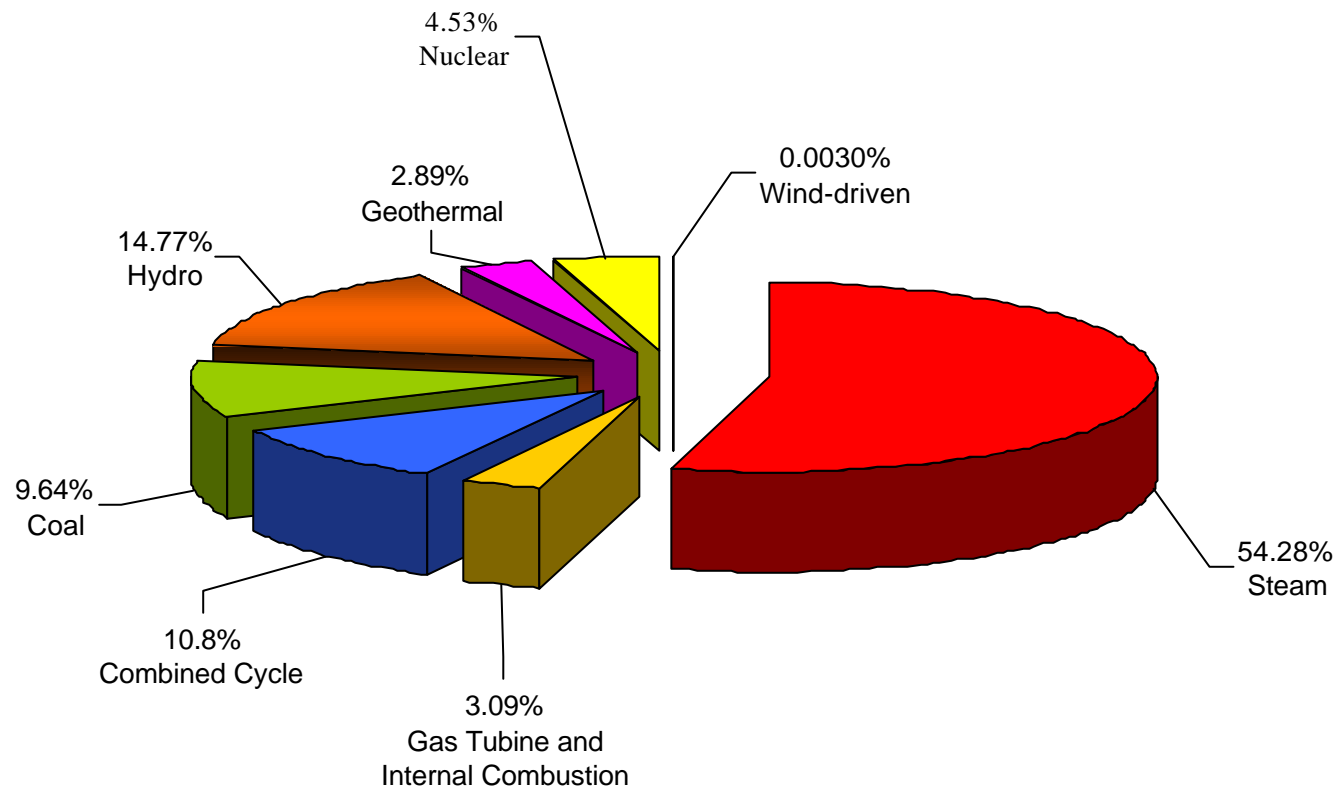


Fossil Fuel Consumption 1964-2001

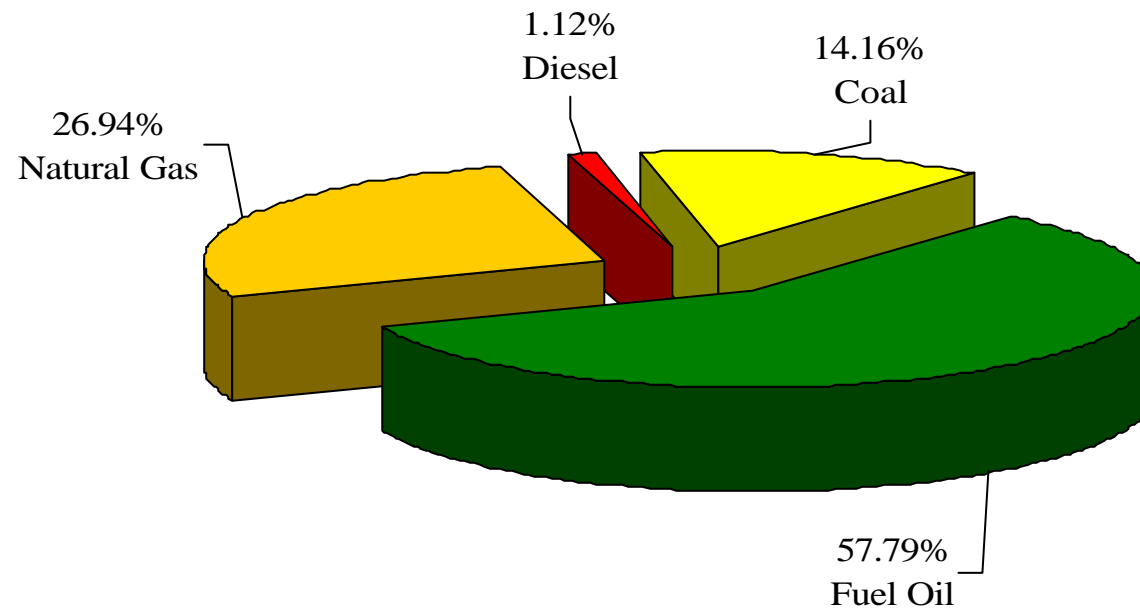


■ Fuel Oil ■ Natural Gas ■ Diesel ■ Coal

Share per Type of Generation in Year 2000



Fuel Share in Electric Generation in Mexico in Year 2000



- During the generation process with fossil fuels 37.821×10 kilocalories were consumed, with the following percentages:

Fuel oil	21,857.0	Kcal x 10^{10}	-----	57.790%
Natural gas	10,187.2	Kcal x 10^{10}	-----	26.94%
Diesel	423.0	Kcal x 10^{10}	-----	1.12%
Coal	5.354.0	Kcal x 10^{10}	-----	14.94%

- The total national electric power production capacity is 37.022 MW.
- Gross demand for year 2001 was 25,628 MW.
- Energy consumption for the year 2001 was 192,517 GWh

Development of coal power plants in Mexico



In Mexico, coal-based electricity began in 1964 with a plant installed in Nava, State of Coahuila with a capacity of one 37.5 MW unit, this plant operated until 1977 with an average consumption of 120,000 tons yearly.

- Pte. José López Portillo (Río Escondido) thermal power plant was put in service in 1981.
- Carbón II thermal power plant was put in service in 1993.

- The Pte. Plutarco Elías Calles (PETACALCO) thermal power plant was put in service in 1993.

Initially, it was fuel oil-fired, but its conversion to coal is under way, with a forecast that by late 2002, the 6 units of the plant will be coal-fired.

Almost all of the coal produced in Mexico is used by the CFE, with purchases of almost 10 million tons of coal for the Río Escondido and Carbón II plants, located in the north of the economy (US-Mexico border), and only 500,000 tons of low-sulfur coal is imported to be mixed with domestic coal and reduce sulfur contents. PETACALCO imports 100% of its requirements of 6 million tons per year.

PETACALCO imports 100% of its 6 million-ton yearly requirements.



Pte. José López Portillo (Río Escondido) thermal power plant

1. Plant Description.

The Río Escondido thermal power plant is located in the north of Mexico, in the State of Coahuila, near the City of Piedras Negras, border with USA.

The coal supplied by MICARE is received in the plant through a belt that unloads through a distributing tower into two silos that feed the coal to the plant through belts, the coal supplied by the small and mid-sized producers of the State of Coahuila is received by train and trucks, using the emergency tower.



2. Current situation (2001).

- Installed Capacity.

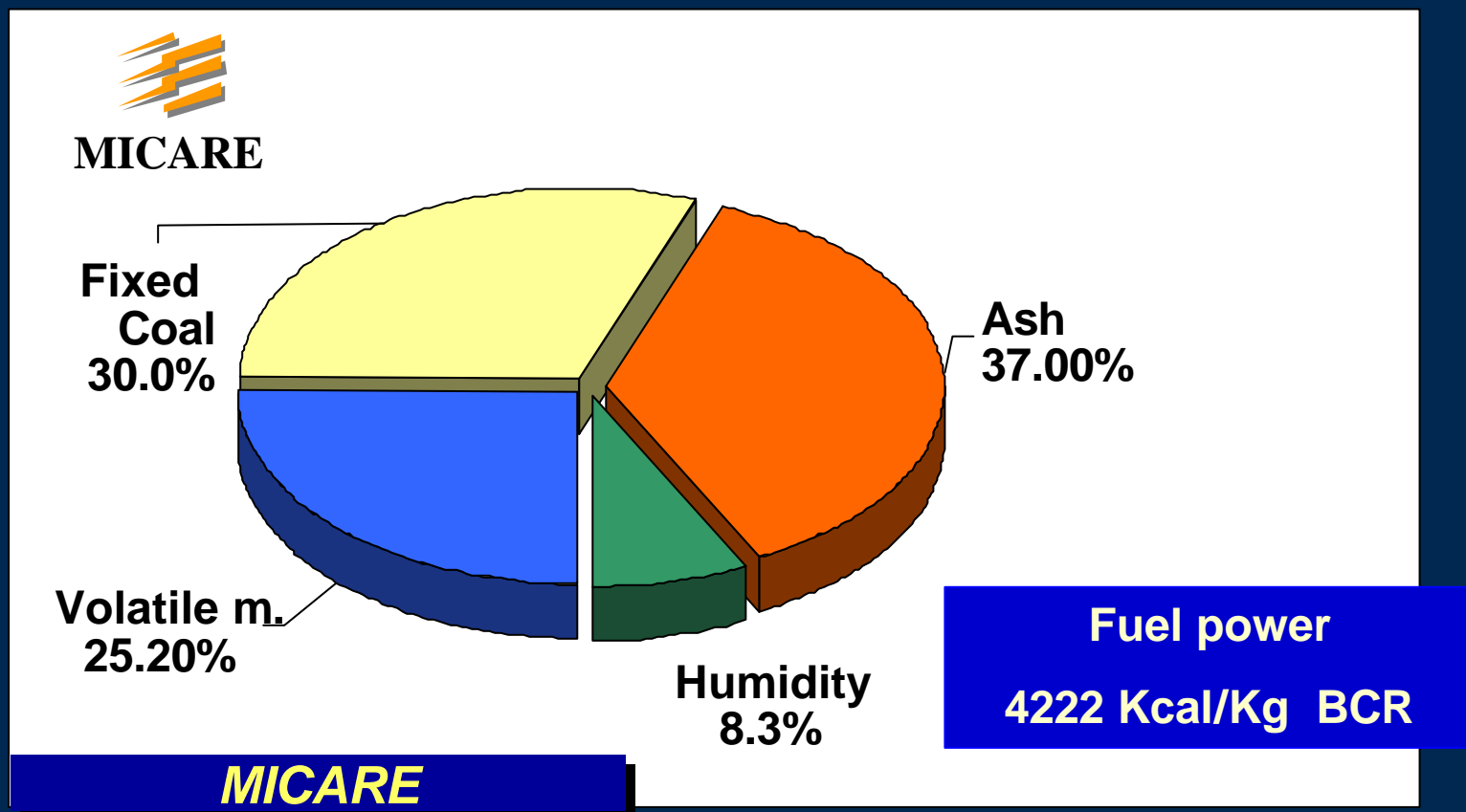
The plant's installed capacity is 1,200 MW consisting of 4-300 MW units.

- Coal Consumption.

At full load, the plant consumes about 5.4 million tons of coal per year.



Coal analysis Río Escondido

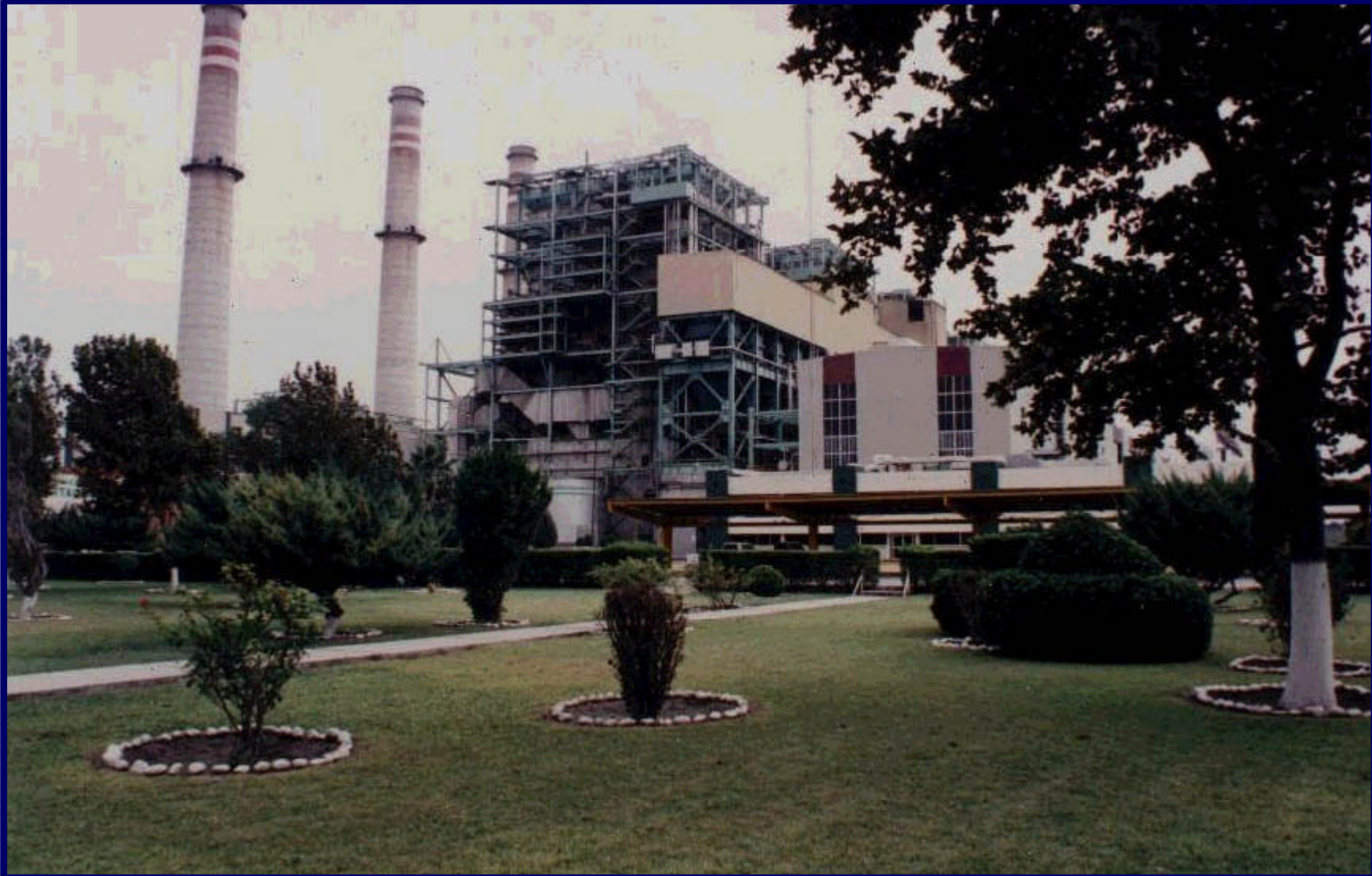


- The characteristics coal are as follows:

Fuel power Kcal/Kg.(bcsr)	4,233
Volatile matter %	25.8 % in weight
Fixed coal %	31.2 % in weight
Humidity %	8.0 % in weight
Ash %	37.0 % in weight
Sulfur %	1.3 %
Milling rate	53
Initial quenching Tempertature °C	1,399

The coal consumed is domestic, 21% comes from the Sabinas Coal Region, exploited by small and medium producers in the region, 79% from the Río Escondido Coal basin, supplied by the company MICARE.







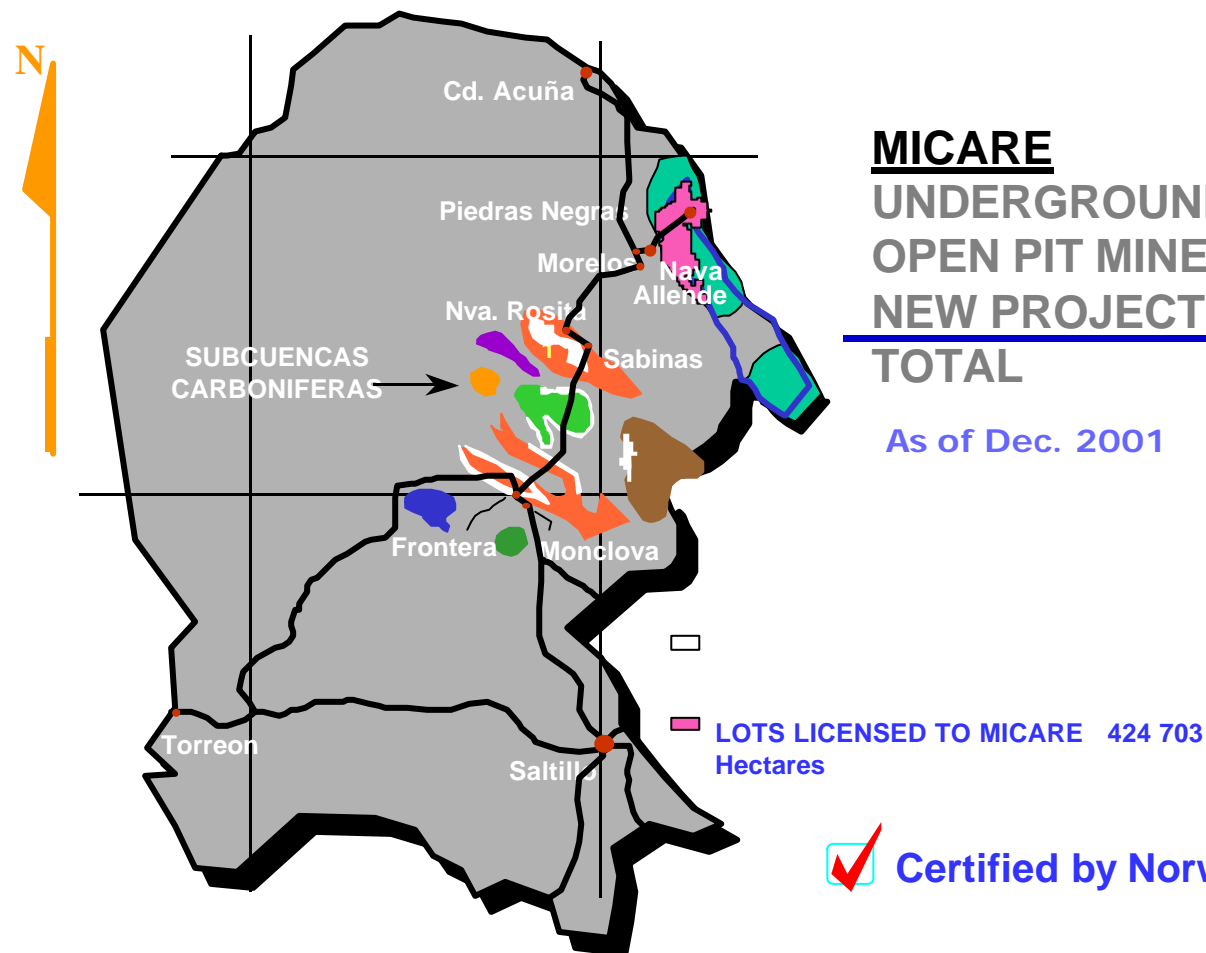




MICARE

Concession

On site reserves



MICARE

UNDERGROUND MINES	52.5
OPEN PIT MINES	57.9
NEW PROJECTS	141.6
TOTAL	252.0



As of Dec. 2001



Certified by Norwest Mine Services Inc.



Carbón II Thermal Power Plant

1. Plant Description

The Carbón II thermal power plant is also located in the State of Coahuila, near the City of Piedras Negras and just 2 km from the Pte. José López Portillo (Río Escondido) thermal power plant.

Imported coal is supplied by rail from the United States of America and domestic coal is supplied by trucks and belts.



2. Current Situation (2001).

- Installed Capacity.

The plant's installed capacity is 1,400 MW consisting of 4 units of 350 MW each.

- Coal Consumption.

At full load, the plant consumes nearly 5 million tons of coal per year, 10% of which is imported low-sulfur coal.



- The imported coal that is purchased by the plant has the following main composition:

Fuel power Btu´s/lb.	9,000-12,000
Volatile matter %	42 Máx.
Fixed coal %	57 Máx
Humidity %	16 Máx
Ash %	17 Máx
Sulfur %	0.7 Máx
Milling rate	45 min.
Initial quenching Tempertature °C	1,150 Min.

A combination of domestic and imported coal is consumed, 43% of domestic coal comes from the Sabinas Coal Region and is exploited by small and medium producers of the region and 47% from Río Escondido Coal Basin.

Currently, imported coal comes mostly from the United States of America, although the price and quality of coal from other countries may be interesting for future purchases.

CARBON II THERMAL POWER PLANT



COAL CONTROL SYSTEM AND STORAGE YARD





Pte. Plutarco Elías Calles (Petacalco) thermal power plant



1. Plant Description

The Pte. Plutarco Elías Calles (Petacalco) thermal power plant is located in the south of Mexico, in the state of Guerrero, near the port of Lázaro Cárdenas, Mich, at the mouth of Balsas river.

The plant was designed to burn fuel oil and/or coal, and even though it started operating with fuel oil, all units are meant to be converted to coal.

All the coal that will be consumed by the plant will be imported, will arrive by ocean and will be received at the coal receiving and handling Terminal built for such purposes, which allows for unloading ships of up to 120,000 metric tons of coal.

2. Current Situation (2001).

- Installed Capacity.

The plant comprises 6- 350 MW units, representing an installed capacity of 2,100 MW.



- Coal Consumption.

At full load, the plant consumes around 6 million tons of coal per year.

Purchasing coal of differing qualities is being considered, in order to mix them directly in the Terminal, benefiting from the advantages of the coal market.

- The potential markets for supply are located in countries such as Australia, Canada, Colombia, United States of America, Indonesia, Russia, South Africa, Venezuela among others.

COMISION FEDERAL DE ELECTRICIDAD

SPECIFICATIONS AND CHARACTERISTICS OF THERMAL MINERAL NON-COKING COAL FOR PRESIDENTE THE PLUTARCO
ELIAS CALLES THERMAL POWER PLANT (PETACALCO)
TYPES OF COAL TO BE PURCHASED

Characteristics Future Analysis	ASTM Standard	LIMITS									
		COAL A		COAL B		COAL C		ORIGINAL COAL		COAL E	
		Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Ash, weight % (bscr)	D-3174		15.0		13.0		8.0		12.2		12.0
Volatile matter, weight % (bscr)	D-3175	25.0	38.0	25.0	38.0	25.0	38.0	25.0	38.0	25.0	38.0
Fixed coal, weight % (bscr)	D-3172	45.0		45.0		45.0		45.0		45.0	
Humidity, weight % (bscr)	D-3302 D- 2961		12.0		11.0		16.0		10.0		14.0
Gross calorific value, kcal/kg (bscr)	D-1989	6,100	6,700	6,100	6,700	6,100	6,700	6,100	6,500	6,100	7,000
Gross calorific value, btu/pound (bscr)		10,980	12,060	10,980	12,060	10,980	12,060	10,980	11,700	10,980	12,600
Sulfur, weight % (bscr)	D-4239		1		1		0.6		1		1
Supplementary feature analysis											
HGI admin. Milling rate	D-409	48		48		45		48		44	
Initial quenching temperature °C (°F)	D-1857	1,300		1,227		1,150		1,227		1,150	













Medium-term Planning

- **José López Portillo (Río Escondido) Thermal Power Plant**

There are no current expansion programs.

Coal consumption is expected to remain steady.

Current coal supply sources will be the same.

●Carbón II Thermal Power Plant

There are no current expansion programs.
Coal consumption is expected to remain steady.

Coal supply sources will be basically the same.
Currently, imported coal comes from the United States of America, although coal from other countries may be appealing for future purchases due to its quality and price.

- **Pte. Plutarco Elías Calles (Petacalco)
Thermal Power Plant**

Expected coal consumption.

A project is being developed to increase the installed capacity and coal consumption accordingly.

The sources considered for coal supply will be the same.

Mexico's Development until 2009

In the long run, the electric system must always operate above the 6% operating reserve margin, therefore, the 60,000 MW installed capacity should be carried to year 2009, considering that currently 8,380 MW are under construction.

The plant construction program includes 18 projects through the Pidiregas system, 1,039 MW in bid process, plus the facilities added between 2001 and 2002. 12,000 MW will be bid for the year 2006, until the desired capacity is reached before year 2009.

The following investments should be made for such years:

- Generation – 20 billion dollars.
- Transmission – 10 billion dollars.
- Distribution – 6.5 billion dollars
- Maintenance, rehabilitation and modernization program – 9.5 billion dollars in 10 years.

In the Altamira zone, we have projects of 900 MW under construction, another one in Monterrey and several others ranging from 450 to 500 MW in different areas of the economy.

- After 2,079 MW start operating in 2001.
- 760 MW will be operational in year 2002.
- By year 2003 another group of 8 projects with 2,500 MW will be completed.
- By year 2004, 700 more MW will be put in service, to attain a total of 10 thousand megas, with 3000, 1300, 3300 and 1800, thus guaranteeing supply until year 2004.

Projects have already been committed and will be put in service during year 2005, representing 2,200 MW, which will allow us to recover the operating reserve margin above 27% between year 2001 and 2002.

The current challenge regarding gas supply is 60% more gas generation by year 2009, because we are currently exceeding demand by 16%, and this is because we, as the CFE, should provide the economy's industry and services sufficient electricity at affordable prices that allow those industries to be competitive worldwide.

The technology of old fuel oil and coal plants changed to the technology of Gas Combined Cycle Plants, in which the investment by capacity is almost half the advantage of fuel, also called thermal efficiency, is greater in an old fuel oil or coal plant. Which results in cheaper power.

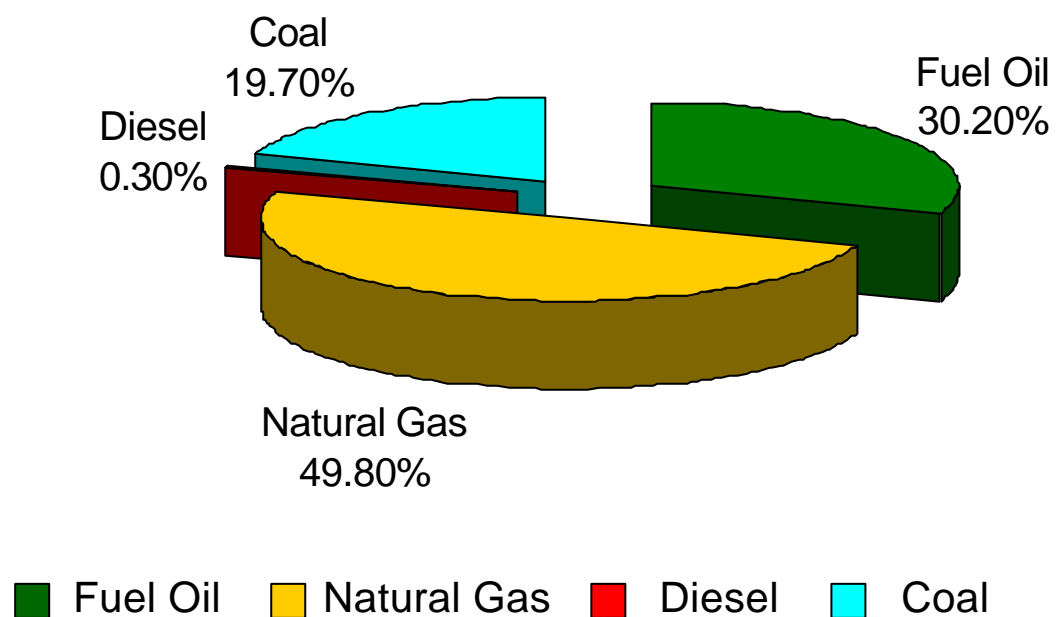
The growth to add 2-350 MW units to the PETACALCO 2 thermal power plant is projected, which requires purchasing 2 additional million tons of coal per year.

Research is under way to make an additional extension to PETACALCO thermal power plant and to build coal plants, however, ports, terminals and special facilities are required and building a coal plant would take from 3 to 5 years.

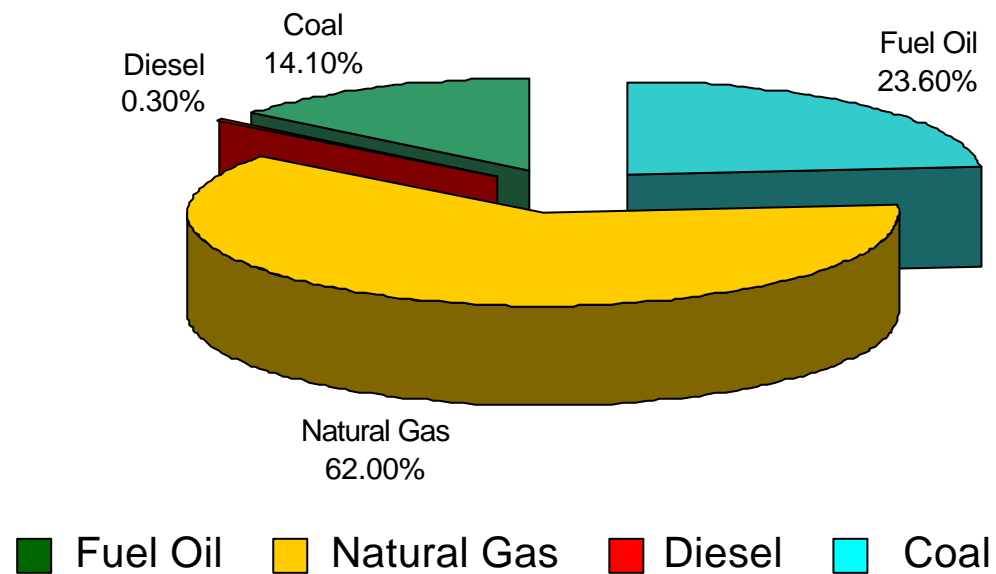
With the current fuel prices (coal, diesel and fuel oil) coal represents the cheaper generation cost.

Electric power has always been relevant for some industries, it is essential for the economy's growth to have competitive prices that allow our industry to be competitive.

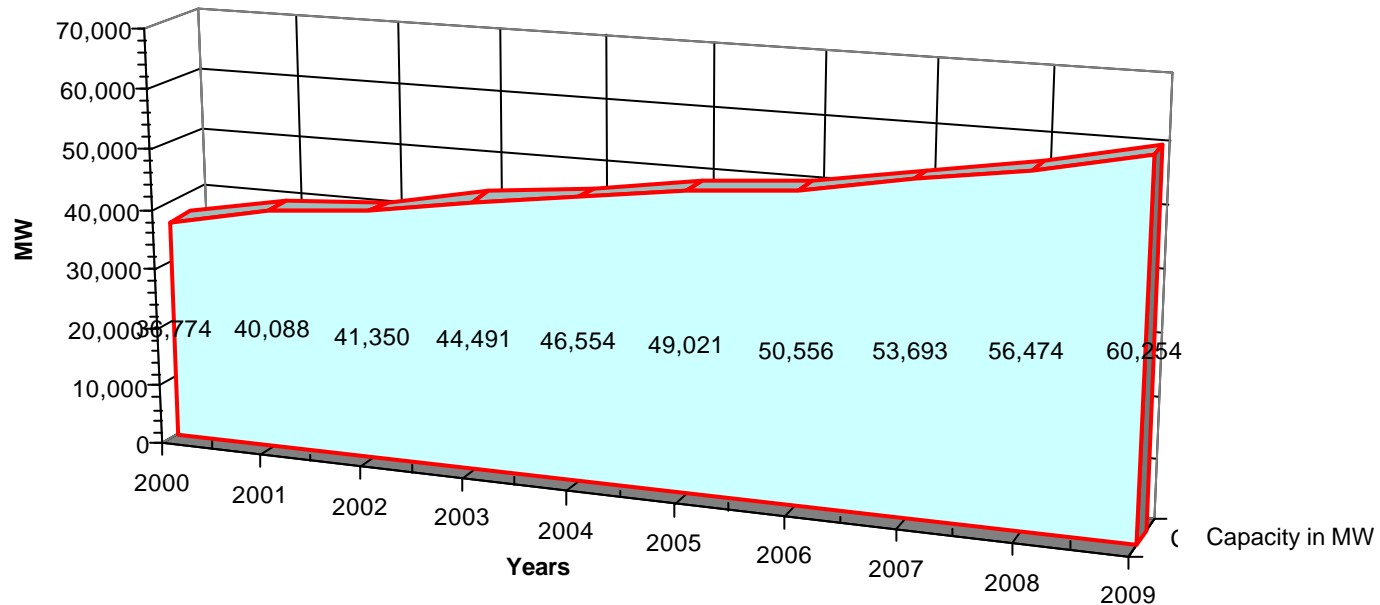
Fuel Share in Consumption for Year 2005 in México



Fuel Share in Consumption of Generation planned for 2009 in Mexico



MEXICO'S NATIONAL ELECTRIC SYSTEM Expected Capacity Growth



MEXICO'S NATIONAL ELECTRIC SYSTEM Estimated Total Sales

